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**SURVEY REPORT FOR THE 1997 AERIAL SURVEYS FOR HARBOR
PORPOISE AND OTHER MARINE MAMMALS OF OREGON,
WASHINGTON AND BRITISH COLUMBIA OUTSIDE WATERS**

By

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INTRODUCTION

We report the methods and the preliminary results of August/September 1997 aerial surveys for marine mammals that occupy the outside coastal waters of Oregon, Washington and southern British Columbia. Estimates of abundance of harbor porpoise and other marine mammals will be computed using data from these surveys and summarized in subsequent reports by the National Marine Mammal Laboratory. Encounter rates, frequency distribution of group size, and other important summary information required for abundance estimation are provided for the most commonly seen species: harbor porpoise, Steller sea lions (*Eumetopias jubatus*), harbor seals (*Phoca vitulina richardsi*) and Dall's porpoise (*Phocoenoides dalli*). On-effort and off-effort sighting distributions for the less common species are also illustrated and summarized.

BACKGROUND

The National Marine Fisheries Service (NMFS) and the US Fish and Wildlife Service (USFWS) are responsible for reducing human-caused marine mammal mortality below levels deemed to be significant based on population estimates within U.S. waters (MMPA, Barlow *et al.* 1995). As a part of this mission, a number of aerial surveys have been conducted over the past 15 years to collect sighting data of marine mammals occupying Oregon and Washington outside coastal waters (Barlow *et al.* 1988, Calambokidis *et al.* 1990, 1991, 1992). Most of these surveys were flown with the primary objective of estimating abundance of harbor porpoise (*Phocoena phocoena*), a species that is incidentally killed in gillnets set for salmon in several areas of this region (Stacey *et al.* 1990, Gearin *et al.* 1995) and has declined in abundance in several areas of the northeast Pacific (central California: Forney *et al.* 1995; southern Puget Sound: Osmek *et al.* 1995).

Calambokidis *et al.* (1993) reviewed these aerial surveys of Oregon/Washington waters and found the 1990 and 1991 survey data (Calambokidis *et al.* 1991, 1992) were suitable for pooling and calculating improved estimates of harbor porpoise abundance. These estimates were subsequently used to calculate potential biological removal (PBR) levels for two recently designated harbor porpoise stocks: (1) Oregon/Washington Coast and (2) Inland Washington (Osmek *et al.* 1996).

To adequately protect these harbor porpoise and other marine mammal stocks, it is recommended that abundance and PBR estimates be calculated at about five-year intervals (Barlow *et al.* 1995). As a result, aerial surveys for harbor porpoise of the inland Washington stock were conducted during August 1996 (Calambokidis *et al.* 1997, Osmek *et al.* 1997) using the same methods as were used during the 1991 surveys (Calambokidis *et al.* 1992). Surveys for harbor porpoise of the Oregon/Washington stock were delayed until summer 1997 (this study) to coincide with harbor porpoise surveys conducted off California by NMFS, Southwest Fisheries Science Center, La Jolla, CA.

Two methodological changes were made for this 1997 survey: (1) altitude was increased from 183 m (600 ft) to 198 m (650 ft) to make these data comparable with those 1997 data collected off California, and (2) water depths out to 200 m were sampled during 1997, compared to mostly 100 m in 1991, to ensure that the subsequent abundance estimate would include virtually all waters off Oregon/Washington where harbor porpoise occur. The waters of southern British Columbia were also flown during 1997, because no dedicated marine mammals surveys have been conducted in this transboundary region even though marine mammals are incidentally taken in fishing gear there (Stacey *et al.* 1990).

METHODS

Study Area

The study area includes the coastal waters of Oregon, Washington, and southern British Columbia south of 49 degrees N latitude, from shore out to a depth of 200 m (Figure 1). The waters of the west half of the U.S./Canada Strait of Juan de Fuca were also surveyed in 1997 to overlap a portion of the 1996 survey area (Calambokidis *et al.* 1997, Osmek *et al.* 1997) and the harbor porpoise stock boundary located at the Strait's west entrance (see Osmek *et al.* 1996).

Survey Design and Procedures

A total of 107 transect lines (152 unique waypoints, Appendix Table A-1) were planned to provide uniform coverage for areas of similar water depths in Regions 1-6 (Figure 1). Except for the parallel transects of Region 1, the lines followed a saw-tooth pattern (Cooke 1985). Transects were generally stratified to sample water depths out to 100 m and 200 m, with most of the effort being expended in the shallower depths where the highest harbor porpoise densities have been observed (Green *et al.* 1992). Region 4 transect lines all extended out to a depth of 200 m because bathymetry was more variable over Heceta Bank. Each transect was designed to be flown once and when possible from south to north to reduce glare from the sun.

Flights generally originated and ended at Hoquium, WA, although both cities of Coos Bay and Newport, OR were also used as a base of operation when southern and central Oregon were surveyed. Other airports such as Port Angeles, WA and Astoria and Tillamook OR were also used for refueling and waiting for improvements in weather to occur.

Surveys were conducted using a high-wing (*Partenavia P-68*) twin-engine aircraft equipped with left- and right-side bubble windows and a belly window. This arrangement made it possible to observe marine mammals slightly ahead of, to the side, and beneath the aircraft. Three experienced observers, located at left, center and right positions in the aircraft viewed the water for marine mammals while the aircraft flew at an altitude of 198 m (650 ft) and a speed of 167 km/hr (90 kts). Observers rotated to a new position at the

beginning of each flight. Surveys were generally limited to visibility conditions of Beaufort sea state 3 or less and cloud cover 50% or less. When a transect line was aborted prematurely because of poor visibility conditions, these lines were later re-flown when conditions improved.

The data recorder, who also navigated from the copilot's chair, entered survey information using a custom Data Acquisition System (DAS) on a laptop computer that was interfaced with a GPS navigational system. Visibility conditions and altitude were recorded at the beginning of a transect line and when conditions changed. The date, time, and location were updated automatically by the computer each minute and when other data entries were made. When a marine mammal sighting was made, the species, group size, number of calves, and any unusual behavior was called out to the data recorder. In addition, the side observers also called out the clinometer-measured angle of the sighting as the group of animals passed abeam of the aircraft so the perpendicular distance (distance from the survey trackline to the sighting) could be determined. The center observer called out sighting angles from a clinometer-calibrated scale mounted above the belly window.

When a group was sighted from center, the observer would delay for 2-3 seconds waiting for the side observers to register their sighting with the data recorder. This method of recording data was used to avoid confusion at a moment when both the center and a side observer would have traditionally reported the same sighting in unison. The center observer also told the recorder if they saw a sighting made by the side observer to provide information on the number of sightings missed by center within the overlapping search area of 90-65 degrees. This practice of recording "center saw" data was discontinued after 22 August because of its possible effect of decreasing the number of sightings made by center.

Data Editing and Preliminary Analysis

Error checks of the electronic data were conducted prior to analysis, both visually and using computer programs written to test for reasonable speed between one-minute position fixes, altitudes, clinometer angles, and species codes (Appendix Table A-2). On several occasions it was found that the GPS failed to provide reliable positions for portions of a flight (e.g., position format error). In these instances, latitude and longitude were interpolated using the time and position which preceded and followed it. Species codes included a designation for probable, but not certain, species identification as well as codes for unidentified species. Probable sightings were included in the data summaries for that species.

RESULTS

Aerial surveys of Regions 1-6 off south British Columbia, Washington, and Oregon were conducted from 15 August through 9 September 1997. A practice flight was conducted on 15 August off of Hoquium WA (Region 2) to re-familiarize all members of the team with survey operations, viewing marine mammals from the air, and recording data. Over the entire survey period, more than 78 hrs of flight time, during 29 flights, including the ferry of the aircraft back to Oxnard, CA, was required to complete the project (Table 1). Of this total, 31.4 hrs were spent surveying on-effort.

Weather conditions during the 1997 survey period were generally favorable for sighting harbor porpoise, except from 11-14 August and 23-28 August when excessive cloud cover and occasional high winds prevailed (Table 2). Approximately 99% (5,329 km) and 93% (5,038 km) of all survey effort (5,396 km) was flown in the acceptable cloud cover categories of 50% and less and < 25% and less, respectively, while 88 % (4734 km) the effort was flown when conditions were Beaufort 2 and less (Table 3). Good weather effort (both Beaufort 2 and less and 25% CC and less) amounted to 82% (4398 km) of the total. It is important to note that this weather condition summary includes all on-effort data (Figure 2), even those sections of transect lines that were flown again when weather conditions improved (roughly 650 km).

A total of 727 sightings of 1290 animals (including 93 calves/pups) from 15 marine mammal species (plus 7 leatherback sea turtle sightings) were made during on-effort portions of the surveys. An additional 140 sightings of 1191 animals (22 calves/pups) were made while off-effort. Harbor porpoise ($n = 360$), Steller sea lions ($n = 130$), harbor seals ($n = 106$), and Dall's porpoise ($n = 68$) were the most frequently sighted marine mammals and accounted for 91% of the on-effort marine mammal sightings. Other on-effort marine mammal group sightings included California sea lions ($n = 30$), northern elephant seals ($n = 9$), a northern fur seal, humpback whales ($n = 8$), gray whales ($n = 10$), a minke whale, a pod of killer whales, and sea otters ($n = 3$). Figures 3-8 illustrates the distribution of these on- and off-effort sightings of animals that are also quantified in Table 4.

The frequency distributions by group size are summarized for the four primary species (Figure 9). The amount of regional variation in mean group size for these species was especially interesting (Table 5). Group sizes for both porpoise species were substantially higher in Regions 4-6 than Regions 1-3. This variation might be related to changes foraging behavior influenced by factors such as the blue water observed near shore in these southern regions and warmer water temperatures brought about by the 1997 El Niño event. Mean group sizes for harbor seals and Steller sea lions varied much less throughout the study area. One exception was for Regions 3 and 6, where the mean group size of Steller sea lions was relatively high and likely influenced by the hauling areas near the mouth of the Columbia River (Region 3) and Rogue Reef (Region 6).

ACKNOWLEDGMENTS

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Table 5. Mean group size by region and species for good weather (25% cloud cover and less and Beaufort 2 and less). Results includes all non-hauled animals sighted by the three primary observers.

Appendix Tables:

Table A-1. Waypoints as illustrated in Figure 1. During the actual surveys, however, the east ends of these transects were either lengthened or shortened to coincide with the shoreline (see Figure 2).

Table A-2. Data codes for the electronic survey data.

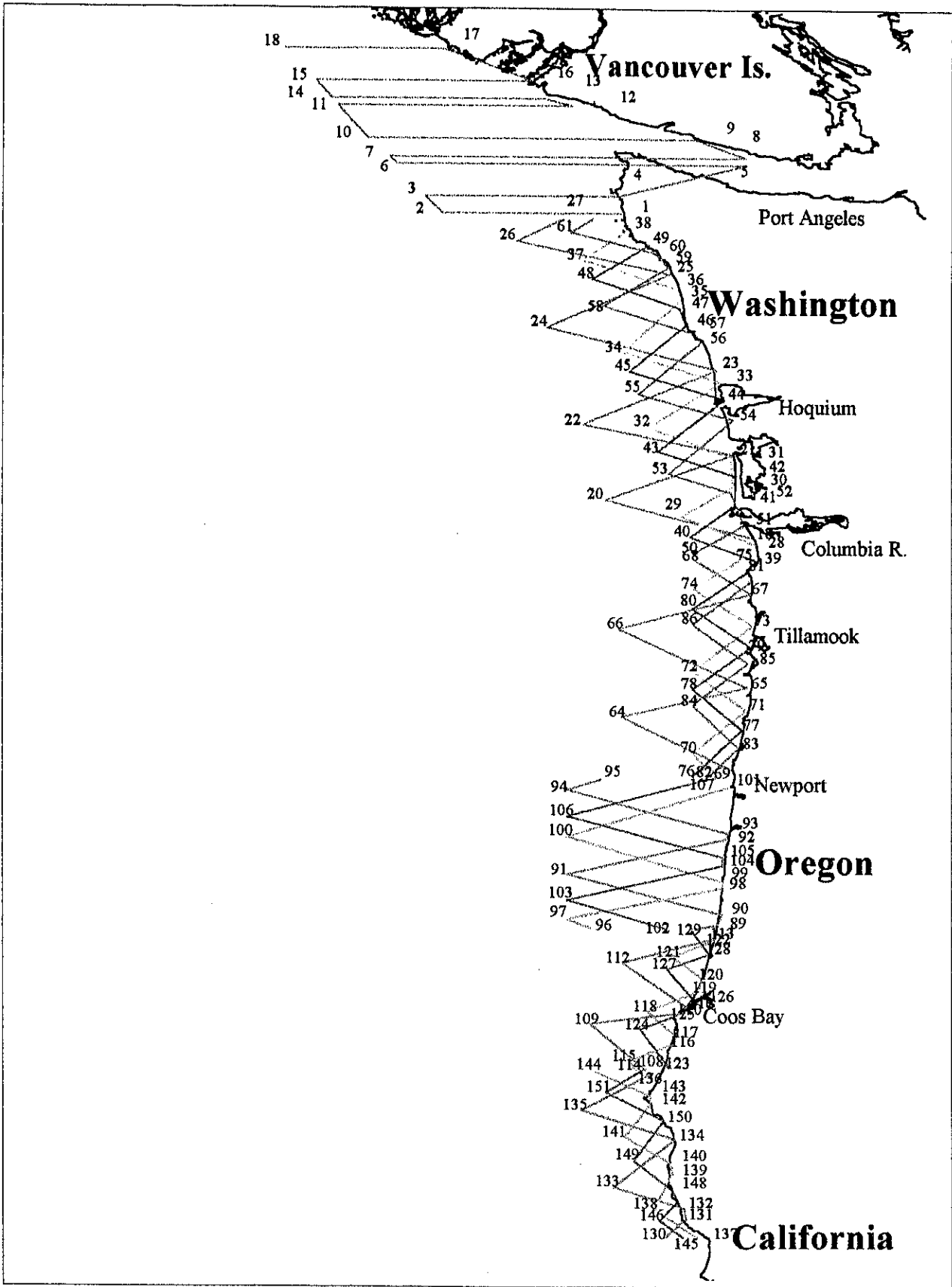


FIGURE 1.

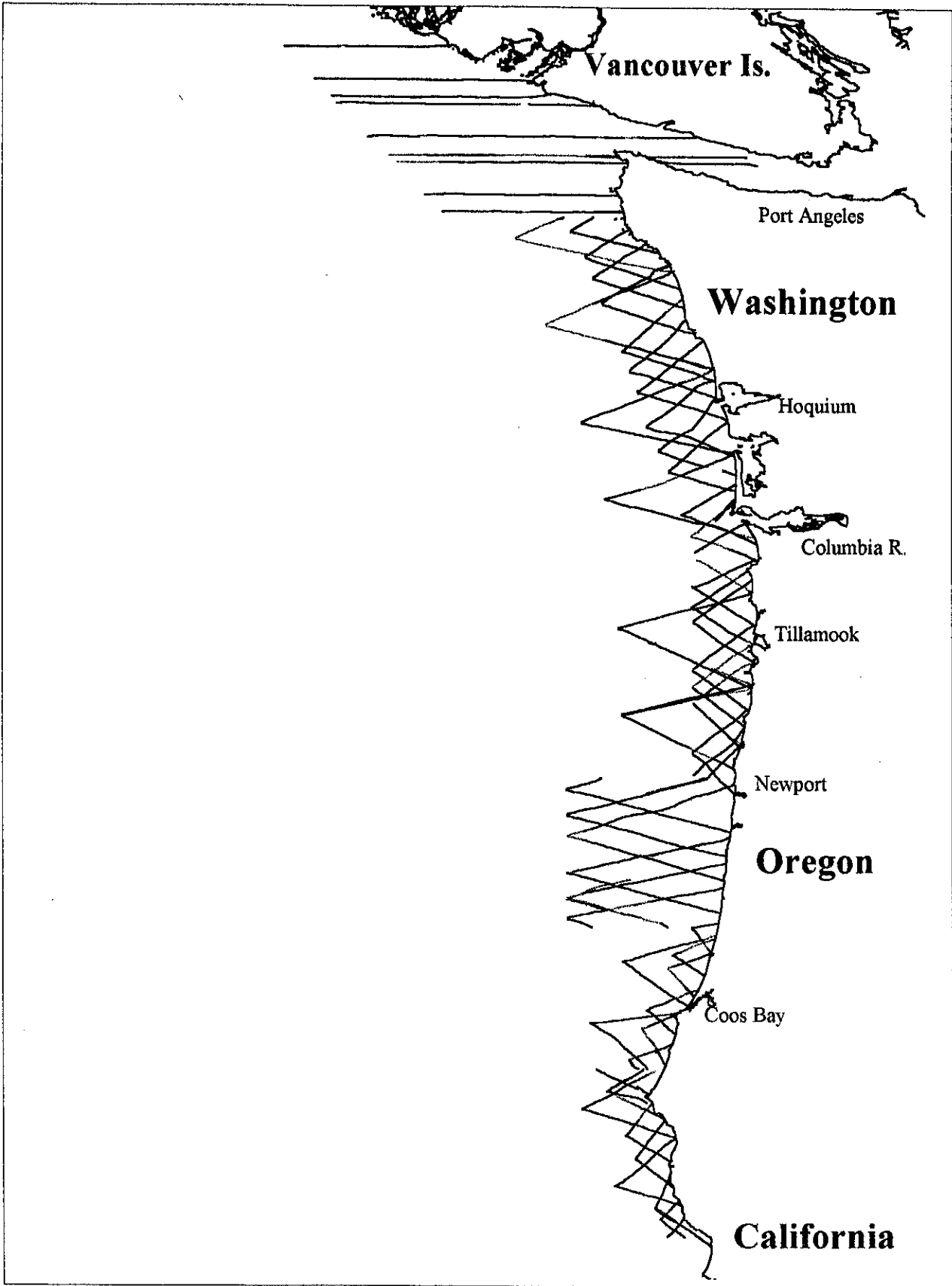


FIGURE 2.

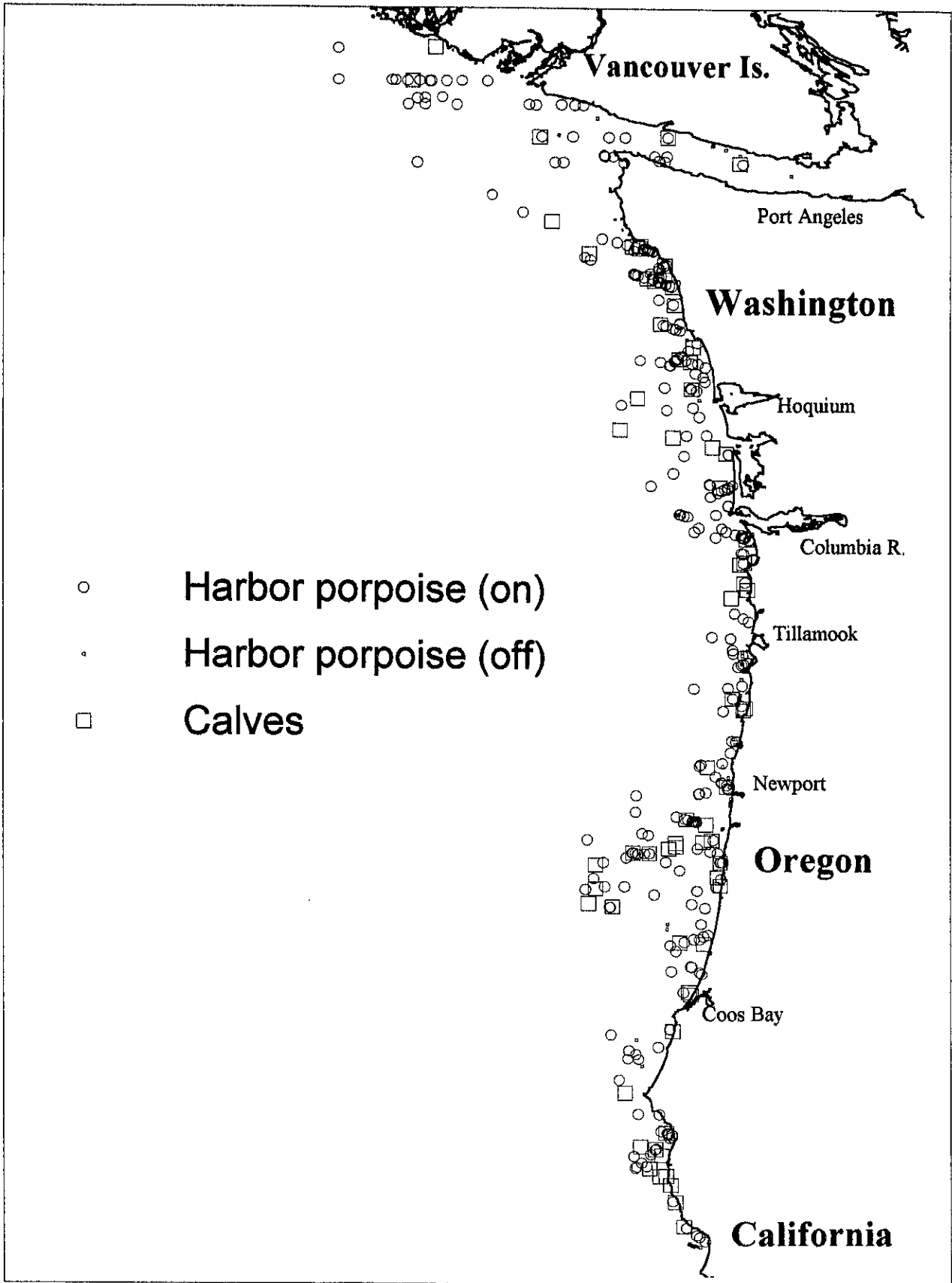


FIGURE 3.

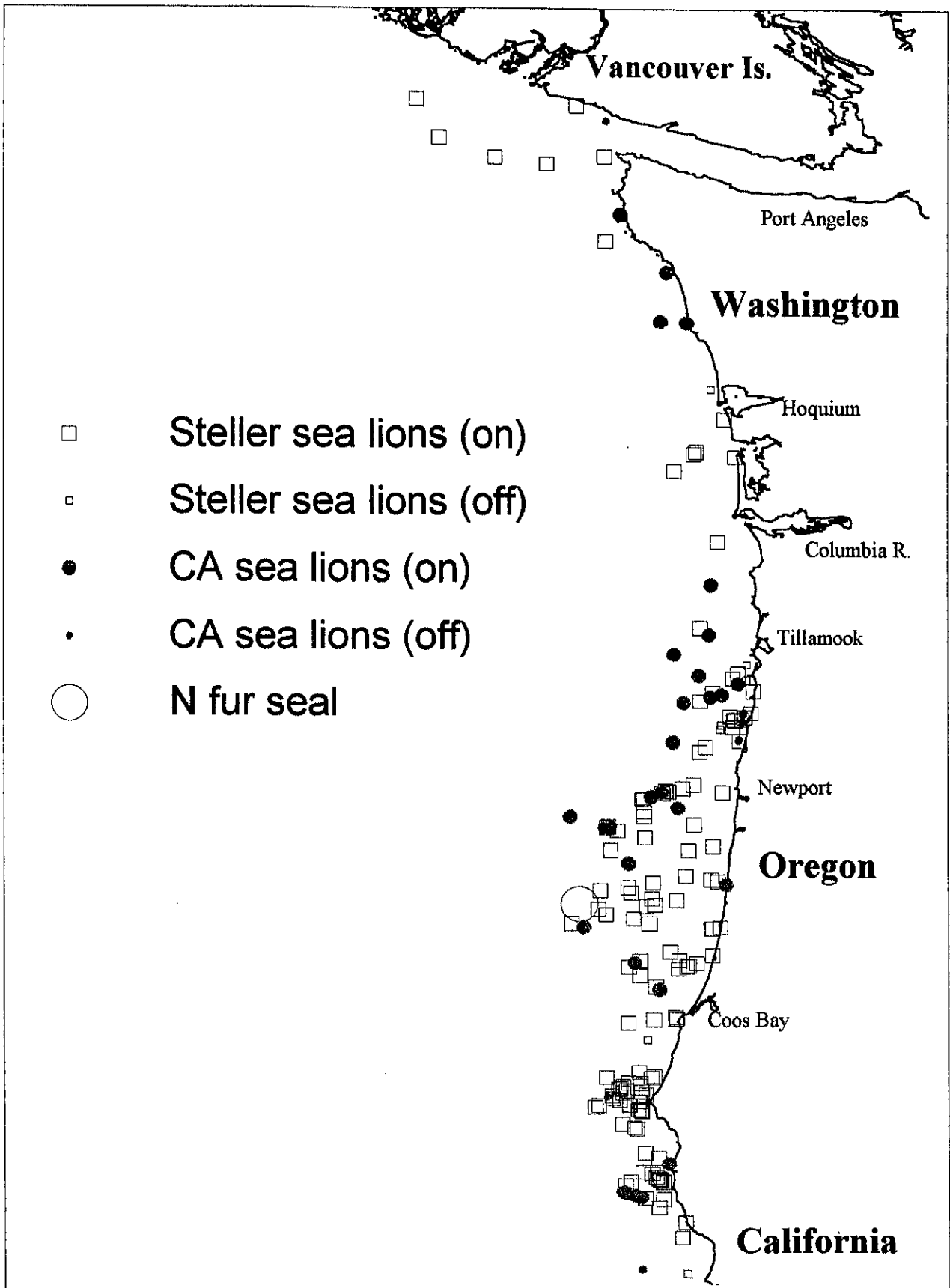


FIGURE 4.

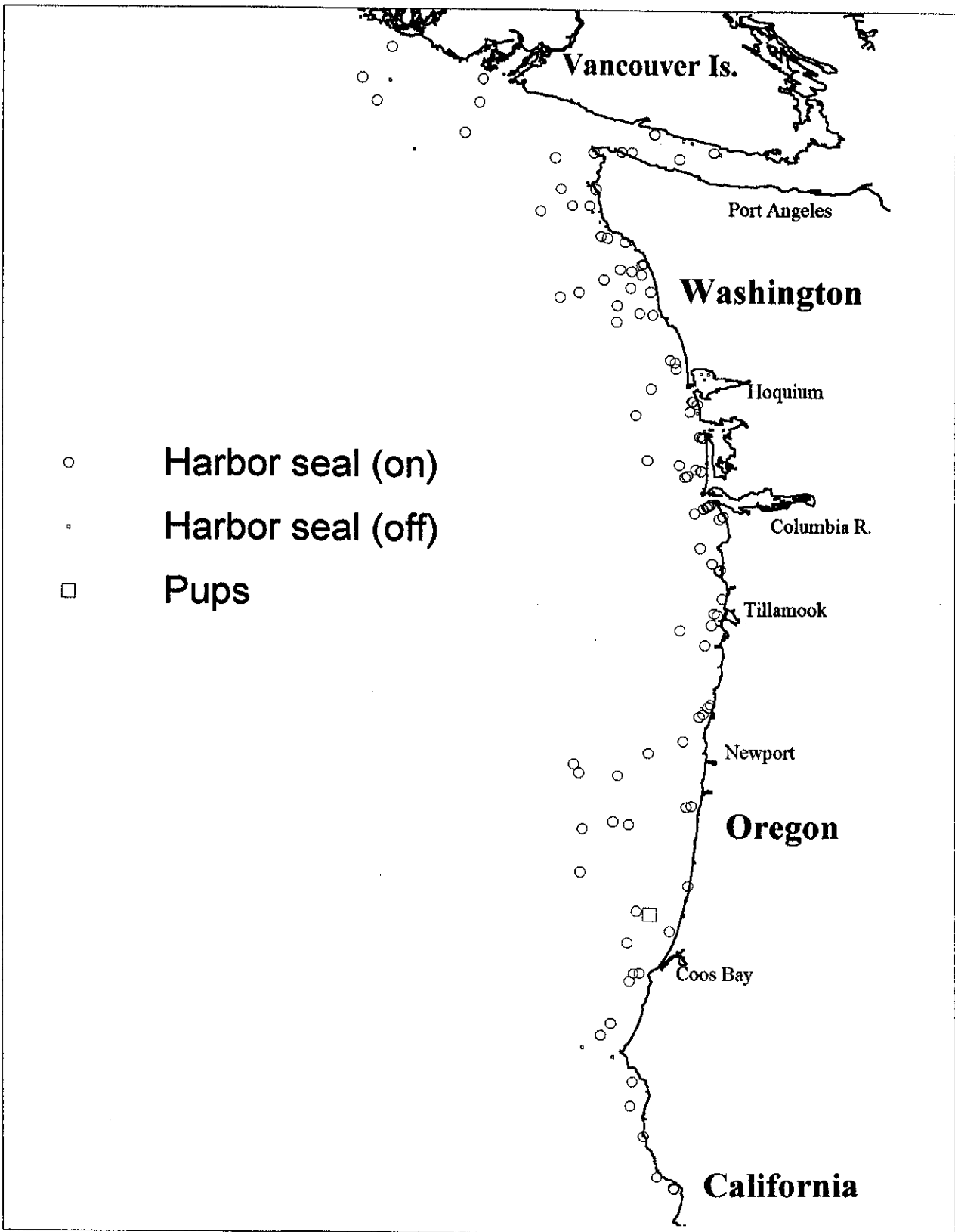


FIGURE 5.

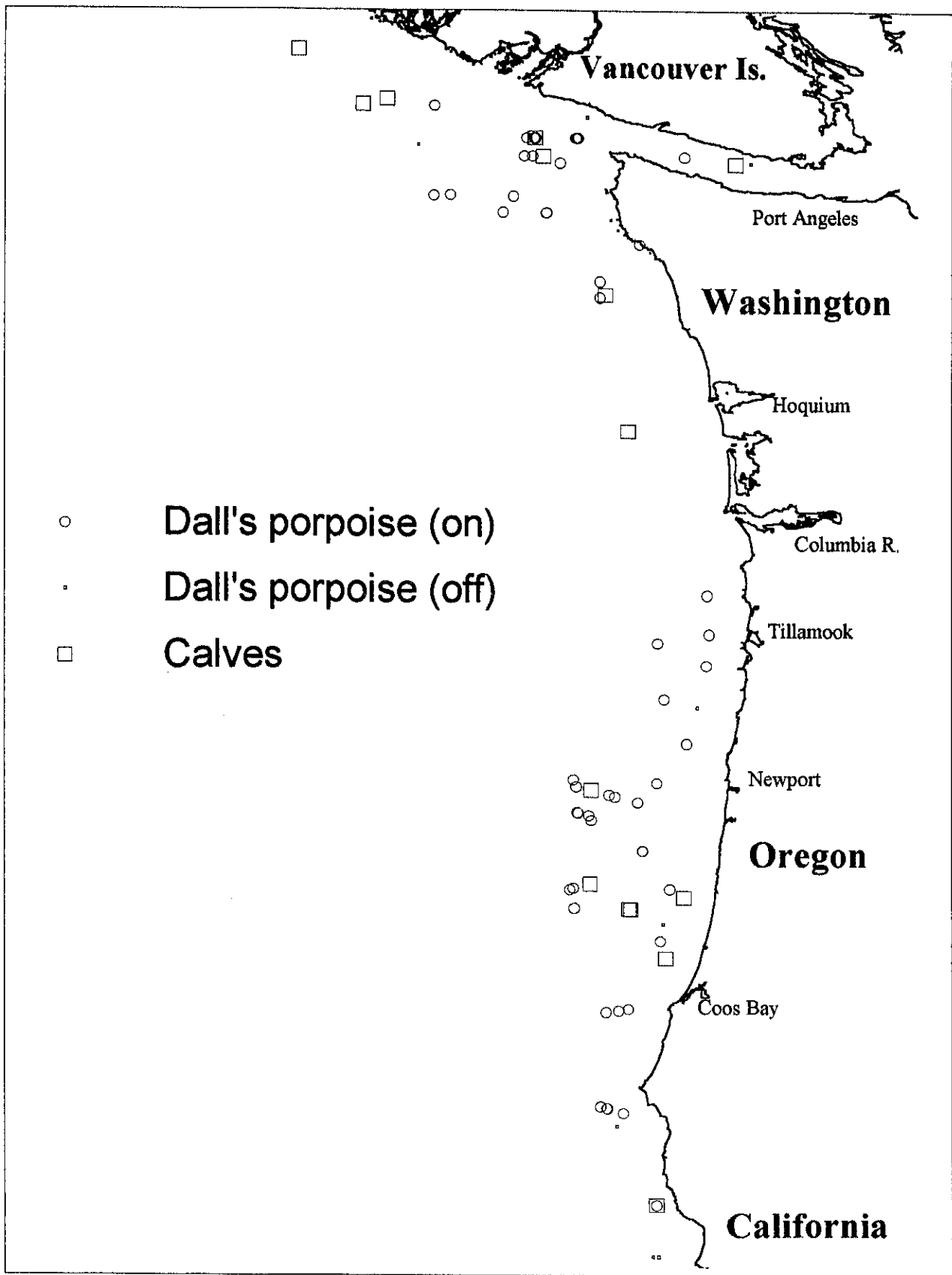


FIGURE 6.

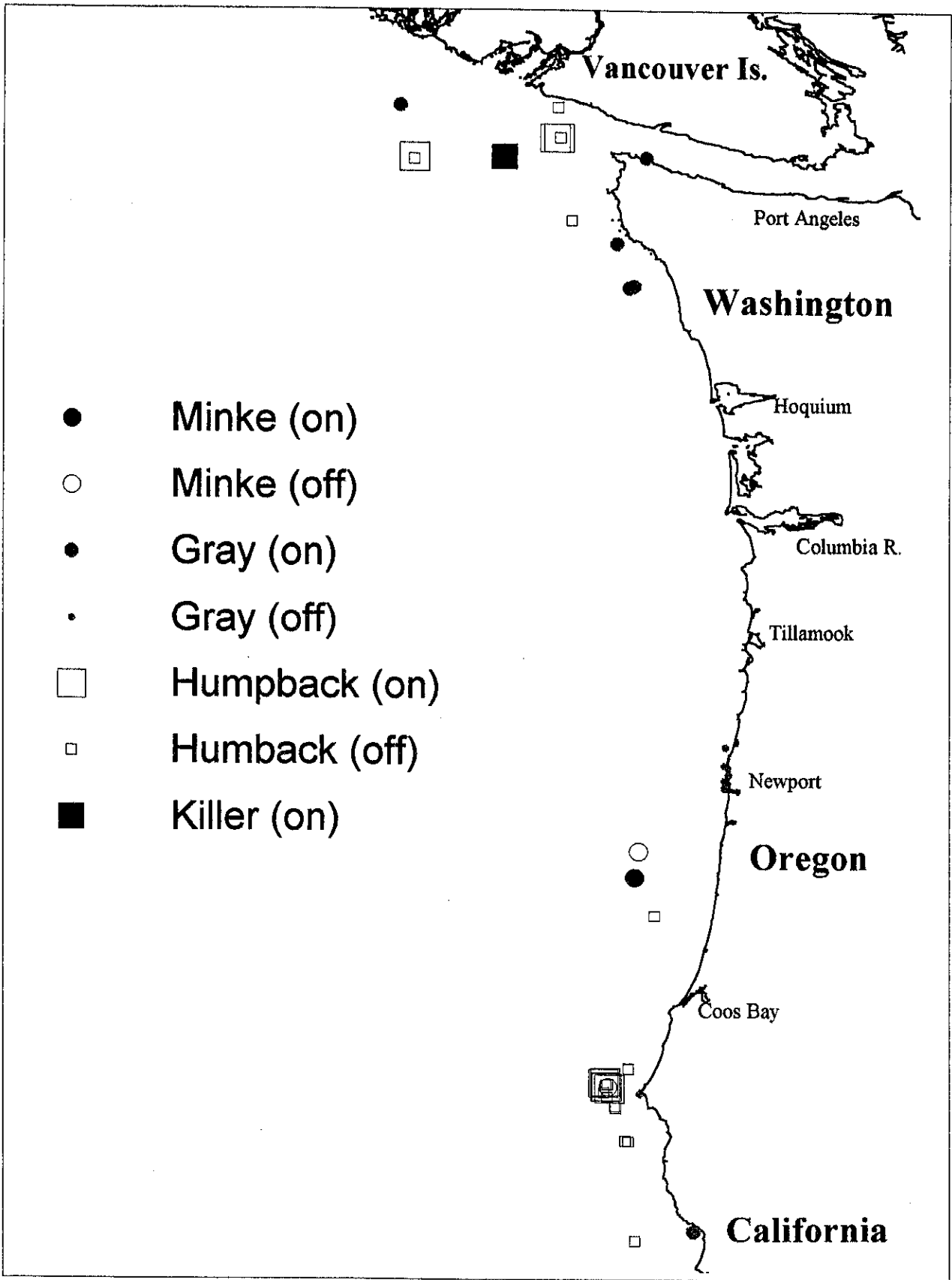


FIGURE 7.

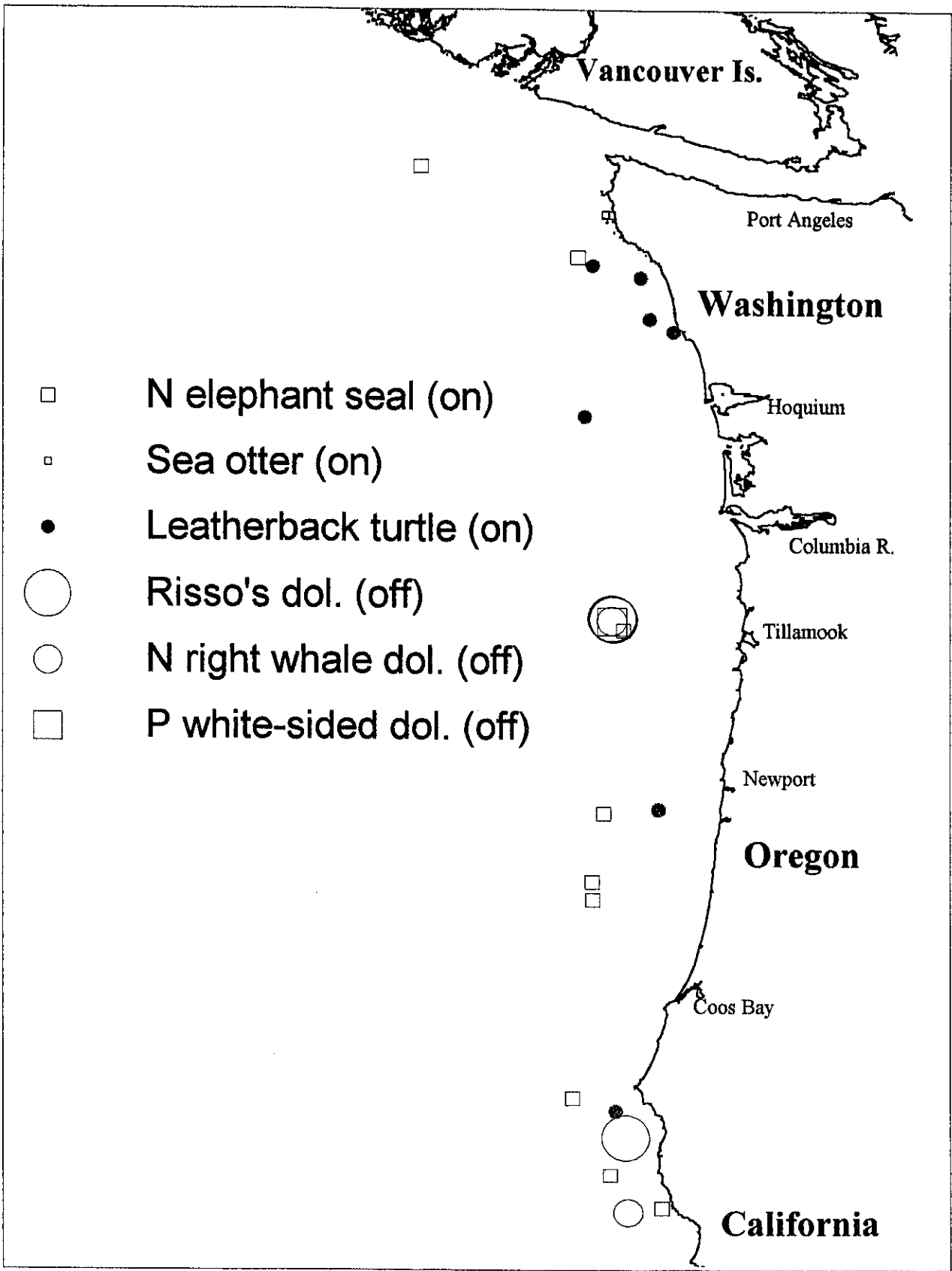


FIGURE 8.

Group Sizes for Species Commonly Observed (n>50)

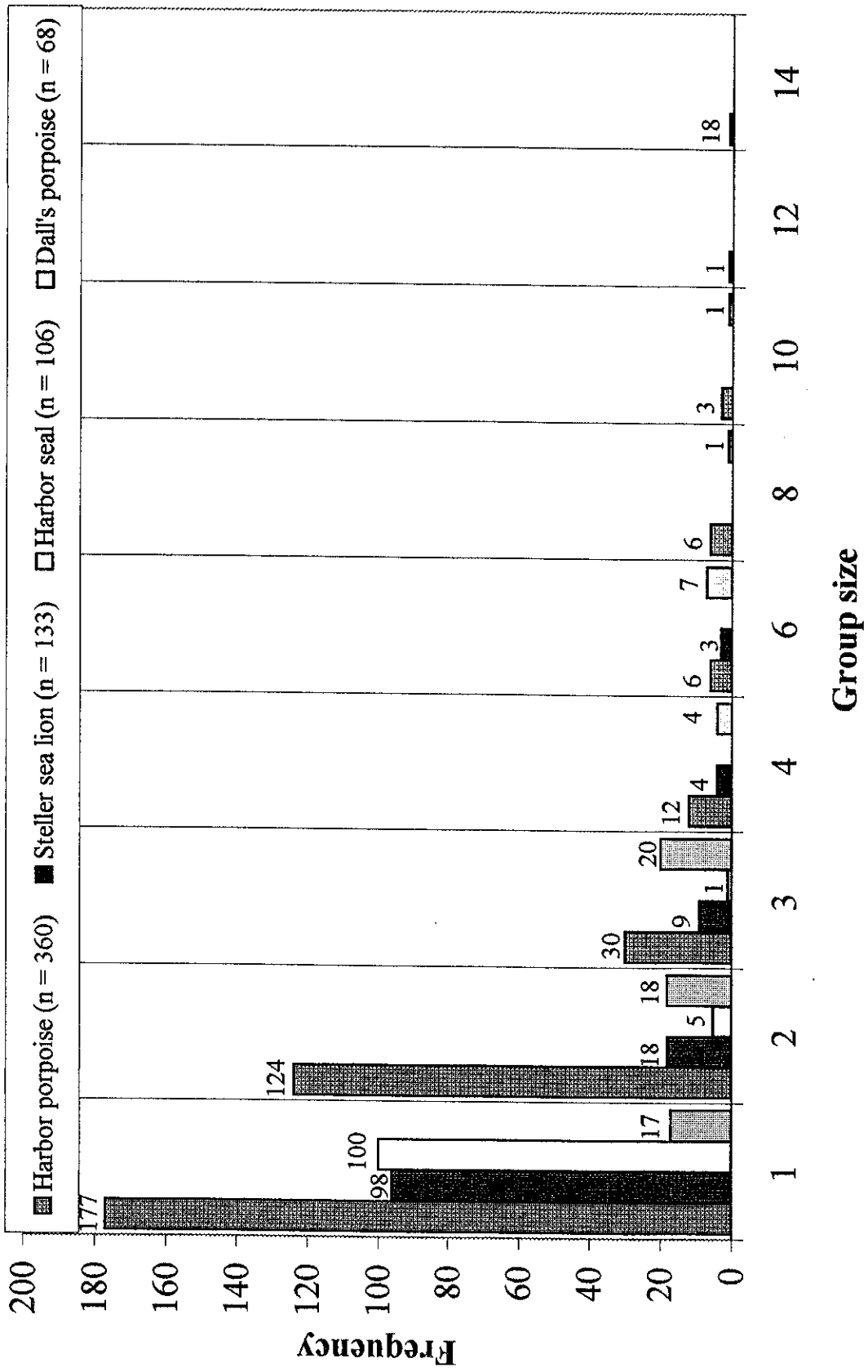


Figure 9.

Table 1. Summary of the 1997 aerial surveys and time expenditures by day.

| Survey date | Regions surveyed or attempted | Departure time | | | Arrival time | | | Time (d-hrs) | |
|----------------------------|--|----------------|---------|----------|--------------|---------|----------|--------------|--------|
| | | Airport | Eng. on | Take off | Airport | Landing | Eng. off | Taxi | Flight |
| 15-Aug | Practice flight | HQM | 14:37 | 14:47 | HQM | 15:28 | 15:38 | 0.01 | 1.02 |
| | Region II | HQM | 17:01 | 17:06 | HQM | 18:14 | 18:23 | 0.01 | 1.37 |
| 16-Aug | Regions II and I | HQM | 10:21 | 10:31 | AST | 13:41 | 13:46 | 0.01 | 3.42 |
| | Region I | AST | 15:09 | 15:17 | HQM | 15:53 | 15:55 | 0.01 | 0.77 |
| 17-Aug | Region I | HQM | 8:18 | 8:30 | PA | 10:43 | 10:46 | 0.01 | 2.47 |
| | Region I | PA | 11:56 | 12:02 | PA | 16:13 | 16:18 | 0.01 | 4.37 |
| | Ferry to Hoquiam from PA | PA | 17:07 | 17:12 | HQM | 17:55 | 17:58 | 0.01 | 0.85 |
| 19-Aug | Region II | HQM | 11:11 | 11:19 | AST | 12:05 | 12:09 | 0.01 | 0.97 |
| | Aborted after attempting Region II | AST | 14:21 | 14:28 | HQM | 15:04 | 15:08 | 0.01 | 0.78 |
| 21-Aug | Regions II and III | HQM | 12:50 | 12:59 | HQM | 18:39 | 18:43 | 0.01 | 5.88 |
| 22-Aug | Regions II and III | HQM | 7:35 | 7:46 | TLMK | 9:08 | 9:11 | 0.01 | 1.60 |
| | Aborted after attempting Region III and II | TLMK | 18:06 | 18:15 | HQM | 19:05 | 19:09 | 0.01 | 1.05 |
| 29-Aug | Regions II, III, IV, V and VI | HQM | 9:51 | 10:01 | COOS | 14:34 | 14:36 | 0.01 | 4.75 |
| 30-Aug | Regions V and VI | COOS | 7:22 | 7:34 | COOS | 12:35 | 12:37 | 0.01 | 5.25 |
| 1-Sep | Region VI | COOS | 9:03 | 9:12 | COOS | 12:45 | 12:49 | 0.01 | 3.77 |
| | Region IV | COOS | 13:43 | 13:50 | COOS | 14:58 | 15:03 | 0.01 | 1.33 |
| 2-Sep | Aborted after attempting Region IV | COOS | 7:59 | 8:08 | COOS | 8:26 | 8:28 | 0.01 | 0.48 |
| | Regions IV and III | COOS | 9:46 | 9:58 | NWPT | 11:25 | 11:28 | 0.01 | 1.70 |
| 3-Sep | Region IV | NWPT | 8:08 | 8:18 | NWPT | 8:49 | 8:52 | 0.01 | 0.73 |
| 4-Sep | Region IV | NWPT | 7:57 | 8:10 | NWPT | 12:41 | 12:43 | 0.01 | 4.77 |
| | Region II | NWPT | 13:27 | 13:36 | NWPT | 14:57 | 14:57 | 0.01 | 1.50 |
| 5-Sep | Region II | NWPT | 9:47 | 9:56 | HQM | 11:21 | 11:25 | 0.01 | 1.63 |
| 6-Sep | Regions II and III | HQM | 8:36 | 8:46 | HQM | 12:23 | 12:25 | 0.01 | 3.82 |
| | Region II | HQM | 13:16 | 13:24 | HQM | 16:46 | 16:49 | 0.01 | 3.55 |
| 7-Sep | Region II and I | HQM | 10:24 | 10:36 | HQM | 13:20 | 13:23 | 0.01 | 2.98 |
| | Region II and III | HQM | 14:19 | 14:27 | HQM | 16:47 | 16:52 | 0.01 | 2.55 |
| 8-Sep | Region I | HQM | 8:10 | 8:19 | PA | 12:33 | 12:35 | 0.01 | 4.42 |
| 9-Sep | Region I | PA | 17:56 | 18:05 | HQM | 20:23 | 20:26 | 0.01 | 2.50 |
| Total flight time | | | | | | | | 0.25 | 70.27 |
| Ferry (back to Oxnard, CA) | | | | | | | | | 8 |
| Total hours | | | | | | | | | 78.51 |

Table 2. Summary of waypoints flown during August- September 1997 and survey conditions.

| Day | Transect line waypoints flown or attempted | Overall conditions* | Comments |
|--------|--|-------------------------------|--|
| 15-Aug | Practice flight | fair | PP, PV, ZC, and EJ sighted, GPS failure |
| | Wpts:33-37 | fair-good | broke effort due to Beaufort 3, no cc |
| 16-Aug | Wpts: 36-38, 1-2, 49-40 | exc-v. good-good-fair-good | increasing cloud cover |
| | Wpts: 28-29 | poor | broke effort due to Beaufort 3 |
| 17-Aug | Wpts: 1-2,6-5 | exc-v. good-good-poor | broke effort due to high winds and fog |
| | Wpts:9-10,11-12,13-14,15-16, 17-18 | exc to fair | fog and winds present offshore |
| | Ferry to Hoquiam from PA | unacceptable | fog and winds present offshore |
| 19-Aug | Wpts:30-29 | poor | winds exceeded beaufort 2 |
| | Aborted | unacceptable | high winds |
| 21-Aug | Wpts:33-28,75-69,76-81,50-56 | exc-good-fair, v good-good | cloud cover > 25%, refuel |
| 22-Aug | Wpts:41-39, 68-67 | v good-good-fair | increasing cloud cover |
| | Aborted | unacceptable | fog and winds present offshore |
| 29-Aug | Wpts: 85-84, 107-106, 92-88, 113-108, 152-151, 123-125 | varied from good-fair | cloud cover > 25%, high winds |
| 30-Aug | Wpts:119-114,126-127,120-122,129-126,142-137,145-152,144-143,135-134 | exc to poor | conditions varied greatly, depending on area |
| 1-Sep | Wpts:136-130, 137-138,144-143,150-152,114-115 | good-v good, exc-v good | refuel |
| | Wpts:102-104 | v good-good-poor | high winds |
| 2-Sep | Aborted | unacceptable | high winds |
| | Wpts: 106-107, 82-84 | good-fair | local areas of high wind |
| 3-Sep | Wpts: 92-91 | good-poor | cloud cover > 25%, high winds |
| 4-Sep | Wpts:101-96,102-107,95-91 | good-exc-v good-exc-v good | offshore winds slight problem |
| | Wpts:63-66 | good-v good-fair | increasing winds |
| 5-Sep | Wpts:19-20 | fair-poor | increasing winds & high sea state |
| 6-Sep | Wpts:23-19, 67-64,85-87 | good-v good | refuel |
| | Wpts:21-27, 62-58 | v good/good/exc/fair | broke due to cloud cover/high winds |
| 7-Sep | Wpts:23-24,57-61,1-4 | exc,exc/good | refuel |
| | Wpts:84-83,64-65 | v good | refuel |
| 8-Sep | Wpts:5-6,11-18,10-9,5-8 | fair-poor, good-exc-good-poor | variable high winds |
| 9-Sep | Wpts:8-7,6-5 | exc-v good-good-fair | high winds, low light level |

*=Conditions are listed either chronologically (-) or by frequency of occurrence (/).

| Reg | Rep | Spt | Ept | Offs | Date | Start time | End time | Hr | Ilkm | GWkm | B0 | B1 | B2 | B3+ | CC<25 | CC26-50 | CC>50 | PPhit | PPno | PPxGW | PPxGW | PVait | PVno | PVsGW | PVnGW | Elait | Elmo | ElxGW | ElnGW | PDait | PDno | PDxGW | PDnGW | | | |
|---------------------------|-----|-----|-----|------|---------|------------|----------|------|------|--------|--------|-------|--------|--------|-------|---------|-------|-------|------|-------|-------|-------|------|-------|-------|-------|------|-------|-------|-------|------|-------|-------|-----|----|-----|
| 6 | 3 | 148 | 149 | | 8/30/97 | 11:05:20 | 11:14:20 | 0.15 | 25.9 | 25.9 | 0.0 | 5.8 | 20.2 | 0.0 | 25.9 | 0.0 | 0.0 | 4 | 11 | 4 | 11 | 1 | 1 | 1 | 1 | 1 | 11 | 31 | 11 | 31 | 0 | 0 | 0 | 0 | | |
| 6 | 3 | 149 | 150 | | 8/30/97 | 11:15:12 | 11:25:18 | 0.17 | 29.6 | 29.6 | 0.0 | 0.9 | 28.7 | 0.0 | 29.6 | 0.0 | 0.0 | 2 | 4 | 2 | 4 | 1 | 1 | 1 | 1 | 1 | 2 | 3 | 2 | 3 | 0 | 0 | 0 | 0 | | |
| 6 | 3 | 150 | 151 | | 9/1/97 | 12:09:06 | 12:16:20 | 0.12 | 20.0 | 20.0 | 0.0 | 20.0 | 0.0 | 0.0 | 20.0 | 0.0 | 0.0 | 1 | 3 | 1 | 3 | 0 | 0 | 0 | 0 | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | | |
| 6 | 3 | 151 | 152 | | 8/30/97 | 11:45:25 | 11:50:26 | 0.26 | 45.6 | 19.2 | 0.0 | 11.7 | 7.5 | 26.4 | 45.6 | 0.0 | 0.0 | 1 | 1 | 1 | 1 | 1 | 0 | 0 | 0 | 6 | 130 | 3 | 127 | 0 | 0 | 0 | 0 | 0 | | |
| 6 | 3 | 151 | 152 | | 9/1/97 | 12:17:17 | 12:22:59 | 0.1 | 17.3 | 17.3 | 0.0 | 16.7 | 0.6 | 0.0 | 17.3 | 0.0 | 0.0 | 1 | 4 | 1 | 4 | 1 | 1 | 1 | 1 | 3 | 3 | 3 | 3 | 0 | 0 | 0 | 0 | 0 | | |
| 6 | 3 | 152 | 151 | | 8/29/97 | 13:45:03 | 13:51:40 | 0.11 | 18.9 | 8.2 | 0.0 | 0.0 | 8.2 | 10.8 | 18.9 | 0.0 | 0.0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 | |
| Region 6 total | | | | | | | | | 3.06 | 527.1 | 463.4 | 0.0 | 152.9 | 324.0 | 50.2 | 513.6 | 13.4 | 0.0 | 38 | 89 | 37 | 88 | 7 | 7 | 7 | 49 | 208 | 44 | 201 | 5 | 19 | 5 | 19 | | | |
| Grand Total (Regions 1-6) | | | | | | | | | 31.4 | 5396.3 | 4398.1 | 182.9 | 1942.9 | 2607.8 | 662.8 | 5038.1 | 291.0 | 67.2 | 359 | 690 | 319 | 616 | 107 | 116 | 96 | 104 | 133 | 315 | 117 | 293 | 67 | 184 | 61 | 163 | 61 | 163 |

- Abbreviations**
- Reg Region
 - Rep Replicate
 - Spt Start Wpt
 - Ept End Waypoint
 - Offs Offshore indicator (f = > 100 m water depth)
 - Ilkm Total number of kilometers flown
 - GWkm Kilometers flown in good weather
 - B Beaufort
 - CC Percent cloud cover
 - PPhit Harbor porpoise sightings
 - PPno No. of animals
 - PPxGW Harbor porpoise sightings in good weather
 - PPnGW No. of animals in good weather
 - PV Harbor seal
 - EJ Steller sea lion
 - PD Dall's porpoise

Table 5. Mean group size by region and species (for GW, on-effort, and primary observers).

| Area | PP | n | PD | n | EJ | n | PV | n |
|----------|------|-----|------|----|------|-----|------|----|
| Region 1 | 1.60 | 40 | 2.14 | 22 | 1.00 | 4 | 1.07 | 15 |
| Region 2 | 1.65 | 125 | 2.00 | 5 | 1.00 | 7 | 1.07 | 41 |
| Region 3 | 1.71 | 35 | 2.00 | 5 | 1.73 | 15 | 1.08 | 13 |
| Region 4 | 2.52 | 62 | 3.42 | 19 | 1.17 | 30 | 1.10 | 10 |
| Region 5 | 2.10 | 20 | 2.40 | 5 | 1.18 | 17 | 1.13 | 8 |
| Region 6 | 2.38 | 37 | 3.80 | 5 | 1.73 | 42 | 1.00 | 7 |
| TOTAL | 1.93 | 319 | 2.67 | 61 | 1.44 | 115 | 1.07 | 94 |

Appendix Table A-1 Waypoints used for the 1997 aerial surveys of coastal Oregon, Washington and British Columbia, Canada.

| Waypoint | Latitude (N) | | Longitude (W) | |
|-------------------------------|--------------|--------|---------------|--------|
| | Deg. | Min. | Deg. | Min. |
| Region I, Replicate 1 | | | | |
| 1 | 48 | 01.800 | 124 | 42.000 |
| 2 | 48 | 01.800 | 125 | 42.000 |
| 3 | 48 | 07.800 | 125 | 48.000 |
| 4 | 48 | 07.800 | 124 | 43.200 |
| 5 | 48 | 19.200 | 124 | 00.000 |
| 6 | 48 | 19.200 | 125 | 57.600 |
| 7 | 48 | 21.600 | 126 | 00.000 |
| 8 | 48 | 21.600 | 124 | 00.000 |
| 9 | 48 | 28.200 | 124 | 16.800 |
| 10 | 48 | 28.200 | 126 | 07.200 |
| 11 | 48 | 39.600 | 126 | 17.400 |
| 12 | 48 | 39.600 | 124 | 58.200 |
| 13 | 48 | 42.000 | 125 | 07.200 |
| 14 | 48 | 42.000 | 126 | 19.200 |
| 15 | 48 | 48.000 | 126 | 24.600 |
| 16 | 48 | 48.000 | 125 | 11.400 |
| 17 | 48 | 59.400 | 125 | 41.400 |
| 18 | 48 | 59.400 | 126 | 34.800 |
| Region II, Replicate 1 | | | | |
| 19 | 46 | 07.740 | 123 | 57.180 |
| 20 | 46 | 21.240 | 124 | 47.040 |
| 21 | 46 | 37.440 | 124 | 04.200 |
| 22 | 46 | 47.880 | 124 | 54.840 |
| 23 | 47 | 07.320 | 124 | 09.660 |
| 24 | 47 | 21.900 | 125 | 06.780 |
| 25 | 47 | 40.860 | 124 | 25.380 |
| 26 | 47 | 52.200 | 125 | 16.680 |
| 27 | 48 | 00.000 | 125 | 01.200 |
| Region II, Replicate 2 | | | | |
| 28 | 46 | 05.400 | 123 | 56.040 |
| 29 | 46 | 15.600 | 124 | 21.600 |
| 30 | 46 | 26.400 | 124 | 04.200 |
| 31 | 46 | 36.600 | 124 | 04.800 |
| 32 | 46 | 46.800 | 124 | 32.400 |
| 33 | 47 | 03.000 | 124 | 08.400 |
| 34 | 47 | 13.200 | 124 | 41.400 |
| 35 | 47 | 31.200 | 124 | 22.200 |
| 36 | 47 | 35.400 | 124 | 22.800 |
| 37 | 47 | 45.600 | 124 | 55.200 |
| 38 | 47 | 55.800 | 124 | 40.200 |

Appendix Table A-1 Continued.

| Waypoint | Latitude (N) | | Longitude (W) | |
|--------------------------------|--------------|--------|---------------|--------|
| | Deg. | Min. | Deg. | Min. |
| Region II, Replicate 3 | | | | |
| 39 | 46 | 00.000 | 123 | 56.400 |
| 40 | 46 | 08.400 | 124 | 18.600 |
| 41 | 46 | 19.800 | 124 | 03.600 |
| 42 | 46 | 30.000 | 124 | 03.600 |
| 43 | 46 | 38.400 | 124 | 29.400 |
| 44 | 46 | 57.000 | 124 | 07.200 |
| 45 | 47 | 06.600 | 124 | 39.000 |
| 46 | 47 | 22.800 | 124 | 19.800 |
| 47 | 47 | 28.800 | 124 | 22.200 |
| 48 | 47 | 39.000 | 124 | 51.600 |
| 49 | 47 | 51.000 | 124 | 32.400 |
| Region II, Replicate 4 | | | | |
| 50 | 46 | 03.000 | 124 | 16.800 |
| 51 | 46 | 12.600 | 124 | 00.600 |
| 52 | 46 | 24.000 | 124 | 04.800 |
| 53 | 46 | 30.600 | 124 | 25.800 |
| 54 | 46 | 49.800 | 124 | 04.200 |
| 55 | 46 | 58.800 | 124 | 36.000 |
| 56 | 47 | 16.800 | 124 | 15.000 |
| 57 | 47 | 19.800 | 124 | 16.800 |
| 58 | 47 | 29.400 | 124 | 48.000 |
| 59 | 47 | 43.200 | 124 | 25.800 |
| 60 | 47 | 48.000 | 124 | 30.000 |
| 61 | 47 | 55.200 | 124 | 58.800 |
| 62 | 48 | 00.000 | 124 | 51.600 |
| Region III, Replicate 1 | | | | |
| 63 | 44 | 46.800 | 124 | 06.000 |
| 64 | 45 | 04.800 | 124 | 41.580 |
| 65 | 45 | 15.420 | 123 | 59.520 |
| 66 | 45 | 36.000 | 124 | 42.600 |
| 67 | 45 | 48.420 | 123 | 58.140 |
| 68 | 46 | 00.000 | 124 | 16.680 |
| Region III, Replicate 2 | | | | |
| 69 | 44 | 43.380 | 124 | 10.320 |
| 70 | 44 | 52.200 | 124 | 17.880 |
| 71 | 45 | 07.200 | 124 | 00.000 |
| 72 | 45 | 21.480 | 124 | 17.880 |
| 73 | 45 | 37.200 | 123 | 57.600 |
| 74 | 45 | 50.400 | 124 | 17.880 |
| 75 | 46 | 00.000 | 124 | 02.400 |

Appendix Table A-1 Continued.

| Waypoint | Latitude (N) | | Longitude (W) | |
|-------------------------|--------------|--------|---------------|--------|
| | Deg. | Min. | Deg. | Min. |
| Region III, Replicate 3 | | | | |
| 76 | 44 | 43.800 | 124 | 17.880 |
| 77 | 45 | 00.360 | 124 | 01.200 |
| 78 | 45 | 14.880 | 124 | 17.880 |
| 79 | 45 | 29.700 | 123 | 58.380 |
| 80 | 45 | 43.200 | 124 | 17.880 |
| 81 | 45 | 56.640 | 123 | 58.740 |
| Region III, Replicate 4 | | | | |
| 82 | 44 | 43.320 | 124 | 13.200 |
| 83 | 44 | 54.000 | 124 | 02.400 |
| 84 | 45 | 09.420 | 124 | 17.880 |
| 85 | 45 | 24.000 | 123 | 59.400 |
| 86 | 45 | 37.800 | 124 | 17.880 |
| 87 | 45 | 52.800 | 123 | 58.200 |
| Region IV, Replicate 1 | | | | |
| 88 | 43 | 50.040 | 124 | 18.420 |
| 89 | 43 | 51.420 | 124 | 09.420 |
| 90 | 43 | 55.080 | 124 | 07.980 |
| 91 | 44 | 09.240 | 125 | 00.000 |
| 92 | 44 | 21.900 | 124 | 06.000 |
| 93 | 44 | 24.000 | 124 | 06.000 |
| 94 | 44 | 39.000 | 125 | 00.000 |
| 95 | 44 | 42.600 | 124 | 48.600 |
| Region IV, Replicate 2 | | | | |
| 96 | 43 | 50.040 | 124 | 51.720 |
| 97 | 43 | 53.400 | 125 | 00.000 |
| 98 | 44 | 04.560 | 124 | 07.560 |
| 99 | 44 | 06.660 | 124 | 07.440 |
| 100 | 44 | 22.620 | 125 | 00.000 |
| 101 | 44 | 40.080 | 124 | 05.400 |
| Region IV, Replicate 3 | | | | |
| 102 | 43 | 50.040 | 124 | 26.520 |
| 103 | 44 | 00.000 | 125 | 00.000 |
| 104 | 44 | 12.540 | 124 | 07.800 |
| 105 | 44 | 15.540 | 124 | 07.800 |
| 106 | 44 | 29.640 | 125 | 00.000 |
| 107 | 44 | 42.840 | 124 | 13.200 |

Appendix Table A-1 Continued.

| Waypoint | Latitude (N) | | Longitude (W) | |
|-------------------------------|--------------|--------|---------------|--------|
| | Deg. | Min. | Deg. | Min. |
| Region V, Replicate 1 | | | | |
| 108 | 43 | 00.000 | 124 | 33.480 |
| 109 | 43 | 16.200 | 124 | 52.320 |
| 110 | 43 | 20.040 | 124 | 22.200 |
| 111 | 43 | 22.440 | 124 | 19.860 |
| 112 | 43 | 37.980 | 124 | 41.280 |
| 113 | 43 | 46.740 | 124 | 10.320 |
| Region V, Replicate 2 | | | | |
| 114 | 43 | 00.000 | 124 | 36.660 |
| 115 | 43 | 03.300 | 124 | 39.240 |
| 116 | 43 | 09.000 | 124 | 24.180 |
| 117 | 43 | 11.640 | 124 | 23.040 |
| 118 | 43 | 20.640 | 124 | 32.880 |
| 119 | 43 | 27.780 | 124 | 16.080 |
| 120 | 43 | 32.220 | 124 | 14.340 |
| 121 | 43 | 40.200 | 124 | 24.480 |
| 122 | 43 | 45.900 | 124 | 10.800 |
| Region V, Replicate 3 | | | | |
| 123 | 43 | 01.020 | 124 | 25.680 |
| 124 | 43 | 14.340 | 124 | 35.220 |
| 125 | 43 | 19.020 | 124 | 23.640 |
| 126 | 43 | 24.900 | 124 | 17.280 |
| 127 | 43 | 35.760 | 124 | 26.220 |
| 128 | 43 | 41.040 | 124 | 12.000 |
| 129 | 43 | 49.380 | 124 | 18.120 |
| Region VI, Replicate 1 | | | | |
| 130 | 42 | 00.000 | 124 | 27.120 |
| 131 | 42 | 07.140 | 124 | 20.160 |
| 132 | 42 | 10.800 | 124 | 20.760 |
| 133 | 42 | 18.360 | 124 | 44.340 |
| 134 | 42 | 35.520 | 124 | 23.640 |
| 135 | 42 | 45.780 | 124 | 55.200 |
| 136 | 42 | 59.220 | 124 | 30.840 |
| Region VI, Replicate 2 | | | | |
| 137 | 42 | 00.000 | 124 | 16.680 |
| 138 | 42 | 10.620 | 124 | 30.840 |
| 139 | 42 | 23.700 | 124 | 24.480 |
| 140 | 42 | 27.180 | 124 | 25.500 |
| 141 | 42 | 36.360 | 124 | 40.740 |
| 142 | 42 | 47.760 | 124 | 32.040 |
| 143 | 42 | 51.000 | 124 | 32.040 |
| 144 | 42 | 59.400 | 124 | 50.340 |

Appendix Table A-1 Continued.

| Waypoint | Latitude (N) | | Longitude (W) | |
|------------------------|--------------|--------|---------------|--------|
| | Deg. | Min. | Deg. | Min. |
| Region VI, Replicate 3 | | | | |
| 145 | 42 | 00.000 | 124 | 21.000 |
| 146 | 42 | 06.360 | 124 | 29.160 |
| 147 | 42 | 13.260 | 124 | 22.740 |
| 148 | 42 | 17.580 | 124 | 24.780 |
| 149 | 42 | 27.780 | 124 | 37.500 |
| 150 | 42 | 42.240 | 124 | 27.420 |
| 151 | 42 | 52.080 | 124 | 47.100 |
| 152 | 43 | 00.000 | 124 | 34.620 |

Appendix Table A-2. Data Acquisition System (DAS) program codes for 1997 harbor porpoise aerial survey data (file name: HP97-ALL.DAS). Line transects where flown over Oregon, Washington, and British Columbia waters from 15 August through 9 September 1997.

| Column | Description of data entry |
|--------|---|
| 1 | Event code |
| 3-6 | Begin waypoint number |
| 7 | Off shore designator |
| 8-11 | End waypoint number |
| 13-14 | Month |
| 16-17 | Day |
| 19-20 | Year |
| 22-23 | Time (Hours) |
| 25-26 | Time (Minutes) |
| 28-29 | Time (Seconds) |
| 31-33 | Position (Latitude degrees) |
| 35-39 | Position (Latitude minutes) |
| 41-44 | Position (Longitude degrees) |
| 46-50 | Position (Longitude minutes) |
| 52-55 | Altitude |
| 57-59 | Sighting number |
| 57+ | Comment only (if no sighting data on line) |
| 61-63 | Species code |
| 65-67 | Angle to sighting |
| 67 | Side of center observer's sighting (L or R) |
| 69-72 | Group size |
| 75-77 | Minimum group size |
| 80-82 | Maximum group size |
| 84-85 | Number of calves or pups |

Appendix Table A-2, continued. Data codes for the DAS program

| | |
|---------|--|
| 93-94 | Behavior code |
| 103-105 | Observer initials |
| 107-109 | Cloud cover |
| 112 | Beaufort scale |
| 114 | Glare left observer |
| 116 | Glare center observer |
| 118 | Glare right observer |
| 120 | Visual quality left observer |
| 122 | Visual quality center observer |
| 124 | Visual quality right observer |
| 126+ | Comment for the sighting on this line |
| 161 | Indicates whether center saw last side observation |

Appendix Table A-2, continued. Data codes for the DAS program

Event code (column 1): 1 digit code representing the reason for data entry. The different codes are as follows:

- 1 = left observer sighting
- 2 = center observer sighting
- 3 = right observer sighting
- 4 = sighting from data recorder or pilot
- 8 = altitude update
- W = Weather
- B = Begin line
- E = End line
- X = short break of a given trackline, usually due a land crossing
- R = Resume on-effort (back over water)
- C = Comment
- O = Observer update for left, center, right, data recorder, pilot positions
- * = aircraft position captured by the DAS program (positions are sampled each minute even when observers were off-effort).

Begin waypoint (columns 3-6): Alpha-numeric code representing the region (letters) and waypoint number at the beginning of the transect line (see attached waypoint table for details).

Offshore (column 7): Indicates if effort is offshore (F) in water depths greater than 100 m.

End waypoint (columns 8-11): Alpha-numeric code representing the region (letters) and waypoint number at the end of the transect line (see attached waypoint table for details).

Month (columns 13-14): Numeric value representing month (e.g. 12 for December).

Day (columns 16-17): Numeric value representing the day of the month.

Year (columns 19-20): Numeric value representing the year (e.g. 96 for 1996).

Time (Hours) (columns 22-23): Numeric value representing the hour (e.g. 13 for the thirteenth hour of the day - Pacific Daylight Savings Time).

Time (Minutes) (columns 25-26): Numeric value representing minutes (e.g. 10 for the tenth minute of the hour).

Time (Seconds) (columns 28-29): Numeric value representing seconds (e.g. 10 for the tenth second of the minute.)

Appendix Table A-2, continued. Data codes for the DAS program

Position (Latitude degrees) (columns 31-33): Numeric value representing the latitude (e.g. N48 for 48 degrees north; 'T' indicates that the position was interpolated based on the time and latitude of the position that proceeded and followed it).

Position (Latitude minutes) (columns 35-39): Numeric value representing the minutes latitude (60 minutes equals one degree).

Position (Longitude degrees) (columns 41-44): Numeric value representing the degrees longitude (e.g. W123 for 123 degrees west; 'T' indicates that the position was interpolated based on the time and longitude of the position that proceeded and followed it).

Position (Longitude minutes) (columns 46-50): Numeric value representing the minutes longitude (60 minutes equals one degree).

Altitude (columns 52-55): Numeric value representing the altitude of the survey aircraft at time of event.

Sighting number (columns 57-59): Numeric code given for the sighting number. DAS numbered the sightings sequentially beginning each time the DAS program was loaded. Skips in the sighting numbers represent that a sighting was removed from the data file.

Species code (columns 61-62): Code representing the species sighted:

- 1 = Harbor Porpoise
- 2 = Harbor Seal
- BA = Minke Whale
- EJ = Northern Sea Lion
- EL = Sea Otter
- ER = Gray Whale
- GG = Risso's Dolphin
- LB = Northern Right Whale Dolphin
- LBT = Leatherback Turtle
- LO = Pacific White-Sided Dolphin
- MA = Elephant Seal
- OO = Killer Whale
- PD = Dall's Porpoise
- TS = Shark (Most Likely Thresher Or Blue)
- UP = Unidentified Pinniped
- UO = Unidentified Otariid
- UW = Unidentified Whale
- ZC = California Sea Lion

Angle to sighting (columns 65 - 67): Numeric value representing the clinometer reading in degrees to animal as it passes abeam of the aircraft (90 degrees = trackline). Angles for the belly observer was estimated from a premarked grid positioned above the viewing port.

Appendix Table A-2, continued. Data codes for the DAS program

Side of aircraft (column 67): Left (L) or right (R) side of the aircraft (for center observer sightings)

Group size (columns 69-72): Numeric value representing the number of animals seen for the specific sighting (number includes all calves or pups in group).

Calves/Pups (column 84-85): Number of calves or pups if seen

Behavior code (column 94): Number: 3 = stationary, 6 = hauled pinniped, 15 = cetacean pectoral fin slap, 32 = alteration of normal activities, 33 = quick dive

Observer initials (columns 103-105): 2 digit code for the using the first letters from the observers first and last name.

Cloud cover (columns 107-109): Numeric code representing percent of cloud cover (e.g. 25 for 25% cloud cover).

Beaufort wind scale (column 111-112): Representing the Beaufort wind scale (1 = Beaufort 1).

Glare: Numeric code representing surface glare conditions.

1 = no glare problems

2 = glare problems - affects search

3 = severe glare - scorched eyeballs

Left observer (column 114)

Center observer (column 116)

Right observer (column 118)

Visual quality: Numeric code of overall impression of ability to see animals

1 = Excellent

2 = Good

3 = Fair

4 = Poor

5 = Unacceptable

Left observer (column 120)

Center observer (column 122)

Right observer (column 124)

Comment for sighting: (columns 126+): Comment about sighting or flight.

Center saw: Numerical code indicating whether the center observer saw the side observer's last sighting. No code indicates the center did not see the sighting. These data were not collected after 22 August 1997.